ECT150
Homework #3 Key
Sr. Professor Wheeler

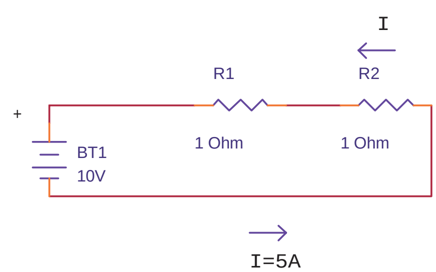
Chapter 4 problems 1-5,7
Total Points: 24 (4 points per problem)

All work must be shown, and final answers boxed or underlined. No credit if work is not shown.

1. If a series string of two equal resistors draws 5 A from a 10 V source, then:

$$R_T = \frac{V_A}{I} = \frac{10V}{5A} = 2\Omega$$ (This is the total resistance of the two equal resistors).

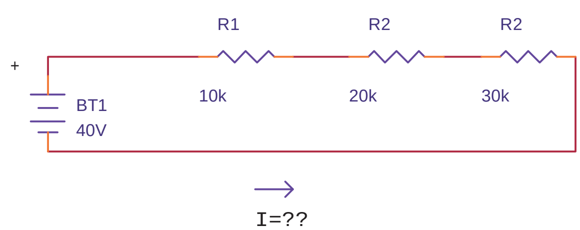
Since resistors in series *add*, we can say that:



$$R_T = R1 + R2 = 2\Omega$$

$$\therefore R1 = R2 = \frac{R_T}{2} = \underline{\underline{1\Omega each}}$$

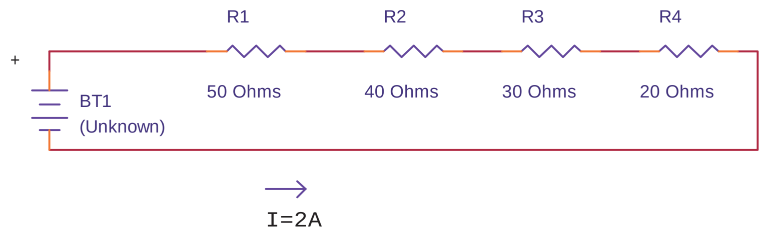
2. What is the current through a series circuit consisting of one 10k, one 20k, and one 30k resistor? The applied voltage is 40V.



The current is found by Ohm's law:

$$I = \frac{V_A}{R_T} = \frac{40V}{R1 + R2 + R3} = \frac{40V}{60k\Omega} = \underline{\underline{0.6\bar{6}mA}}$$

3. Draw a diagram of a series circuit containing resistors having values of 50 Ω, 40 Ω, 30 Ω, and 20 Ω. Label the 50 Ω resistor as R1. Calculate the following:



a) What is R_T?

$$R_T = R1 + R2 + R3 + R4 = 50\Omega + 40\Omega + 30\Omega + 20\Omega = \underline{\underline{140\Omega}}$$

b) What is the applied voltage V_A if I=2A?

$$V_A = IR_T = (2A)(140\Omega) = \underline{\underline{280V}}$$

c) What is the voltage drop across each resistor?

$$V_{R1} = IR1 = (2A)(50\Omega) = \underline{\underline{100V}}$$

$$V_{R2} = IR2 = (2A)(40\Omega) = \underline{\underline{80V}}$$

$$V_{R3} = IR3 = (2A)(30\Omega) = \underline{\underline{60V}}$$

$$V_{R4} = IR4 = (2A)(20\Omega) = \underline{\underline{40V}}$$

d) What is P_T?

$P_T = V_T I = V_A I = (280V)(2A) = \underline{\underline{560W}}$ (Can also be found by I^2R_T)

e) What power is dissipated by R2? By R4?

$$P_{R2} = I^2 R_2 = (2A)^2(40\Omega) = \underline{\underline{160W}}$$

$$P_{R4} = I^2 R_4 = (2A)^2(20\Omega) = \underline{\underline{80W}}$$

f) What fractional portion of V_T is dropped by R4?

The fraction can be expressed as:

$\frac{V_{R4}}{V_T} = \frac{40V}{280V} = \underline{\underline{0.143}}$ (V_{R4} was calculated in part "c" above)

g) If R3 increases in value while others remain the same, what happens to:

1) R_T increases (total is sum of all resistors)
2) I decreases ($I=V/R_T$, where R_T increased)
3) V1,V2,V4: Unknown, these are invalid circuit descriptors (perhaps author means VR1, VR2, VR4; in that case, these voltages will decrease since current decreased)
4) P_T decreases since R_T increases ($P_T=V^2/R_T$)

4. According to Kirchhoff's voltage law, if a series circuit contains components dropping 10V, 20 V, 30 V, and 50 V, respectively, what is V applied? What is the algebraic sum of voltages around the complete loop, including the source?

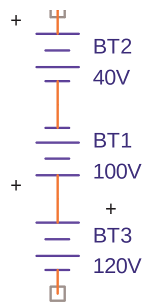
a) $V_A = \sum V_{DROPS} = 10V + 20V + 30V + 50V = \underline{\underline{110V}}$

Note: The symbol $\sum$ is the Greek letter Sigma, and is read as "the sum of" in the above formula.

b) Kirchhoff's voltage law states that the sum of voltage rises (from voltage sources) and drops (from other components) around a complete loop must always be zero.

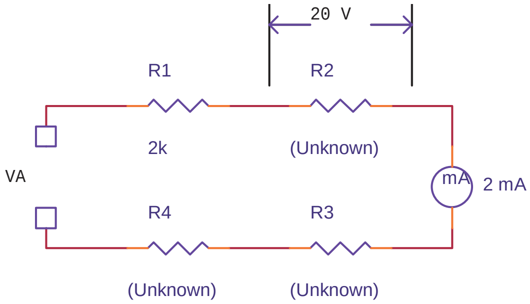
5. Draw a diagram showing how you would connect three voltage sources to acquire a circuit applied voltage of 60V, if the three sources equaled 100 V, 40 V, and 120 V respectively.

This solution involves a little "cut and try" to get it right. One solution looks like this:



BT1 and BT3 "buck" each other to produce +20 V, which aids BT2 (+40V). There's no "real" reason to do this in practice; in fact, this is quite unhealthy for the batteries!

7. Given figure 4-40, find:



Note to students: You can't solve for the requested values in this problem in the same order that the text asks for them! You must find R2 first, then solve for R3 and R4. Once you know all the resistors, you can then find the total voltage V_A.

a) $V_A = I \times R_T = 2mA(R1 + R2 + R3 + R4) = 2mA(2K + 10K + 2.5K + 2.5K) = \underline{\underline{34V}}$

b) R4 and R3 are equal values and dissipate 20 mW (together) with 2 mA current flowing in them. Therefore, Ohm's law can be used to find them:

$$P = I^2 R = I^2 (R3 + R4)$$

$$\therefore (R3 + R4) = \frac{P}{I^2} = \frac{20mW}{2mA^2} = 5K\Omega$$

Since R3 and R4 are equal, $\underline{\underline{R3=R4=5K/2=2.5\ K\Omega}}$

c) $R2 = \frac{V_{R2}}{I_{R2}} = \frac{20V}{2mA} = \underline{\underline{10k\Omega}}$